HYDROGEN INTERACTION WITH TIN FILMS

E.A.Denisov, I.E.Gabis, T.N.Kompaniets, A.A.Kurdyumov, A.A..Yukhimchuk *.
Research Institute of Physics, St. Petersburg State University, 198904, St. Peterhoff, St. Petersburg, Russia
** Russian Federal Nuclear Center, Research Institute of Experimental Physics*
E-mail: kompan@paloma.spbu.ru

Hydrogen permeation through two-layer membranes TiN-Ni and TiN-stainless steel was studied by means of traditional permeation technique. In some cases atomic hydrogen and the method of hydrogen concentration pulses were used for an extended analysis of permeation process.

The study of TiN films on nickel has shown that these films are unstable. Prolonged heating of TiN-Ni membranes at the temperature higher than 500C as well as hydrogen permeation through these membranes with Ni at the upstream side lead to destruction of the coatings. TiN films on stainless steel have a high stability up to the temperature ~650C and essentially reduce the net permeability.

Two different dependencies of permeation on reverse temperature were observed for TiN - stainless steel membranes. The value of permeation activation energy was about 1.4eV at elevated temperatures and ~0.6 eV at T<500C. Such a decrease of activation energy with the decrease of temperature could be accounted for the appearance of an additional mechanism of hydrogen permeation at low temperature. Tests with atomic hydrogen give the evidence that this mechanism is migration of hydrogen along grain boundaries.

It follows from the analysis of permeation isotherms and kinetic measurements that an increase in the time lag in the onset of a steady-state permeation flux and a decrease in the flux value at elevated temperatures are governed with a low rate of dissociative adsorption of hydrogen molecules. The high value of activation energy of adsorption obtained for TiN arrises from the low density of states at Fermi level.

Impurities, stoichiometry, micro and macro structure of the films have a profound effect on permeability and should be taken into account. For some samples, which have a special composition, hydrogen permeation with the high activation energy (and hence the essential decrease of the net permeability) was observed at the temperatures as low as 350C.